US009198691B2

(12) **United States Patent**
Kirschman

(10) **Patent No.: US 9,198,691 B2**
(45) **Date of Patent: *Dec. 1, 2015**

(54) **OFFSET MULTIAXIAL OR POLYAXIAL SCREW, SYSTEM AND ASSEMBLY**

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(73) Assignee: **X-spine Systems, Inc.**, Miamisburg, OH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/935,601**

(22) Filed: **Jul. 5, 2013**

(65) **Prior Publication Data**

US 2013/0296948 A1 Nov. 7, 2013

Related U.S. Application Data

(63) Continuation of application No. 13/214,428, filed on Aug. 22, 2011, now Pat. No. 8,480,714, which is a continuation of application No. 11/960,119, filed on Dec. 19, 2007, now Pat. No. 8,029,539.

(51) **Int. Cl.**
A61B 17/70 (2006.01)
A61B 17/86 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 17/70*** (2013.01); ***A61B 17/7032*** (2013.01); ***A61B 17/7037*** (2013.01); ***A61B 17/7038*** (2013.01); ***A61B 17/7082*** (2013.01); *A61B 17/861* (2013.01)

(58) **Field of Classification Search**
CPC A61B 17/70; A61B 17/7032; A61B 17/7037; A61B 17/7038; A61B 17/7082; A61B 17/861
USPC 606/246–248, 251, 253, 257, 264–272, 606/301, 305, 306, 308, 320; 411/398; 280/86.753
See application file for complete search history.

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Primary Examiner — Pedro Philogene
Assistant Examiner — David C Comstock
(74) *Attorney, Agent, or Firm* — Jacox, Meckstroth & Jenkins

(57) **ABSTRACT**

A capless multiaxial screw fixation assembly, including a screw having a threaded portion and a screw head portion positioned at one end thereof and a retainer having a first end, a second end opposite the first end, and a bore for receiving the screw threaded portion so that the screw head portion is seated therein. At least one of the screw and the retainer is configured such that the retainer is able to pivot about the screw head portion in a non-symmetrical manner.

11 Claims, 16 Drawing Sheets

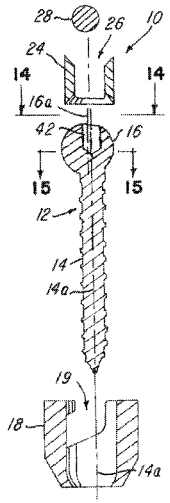

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FIG-1
(PRIOR ART)

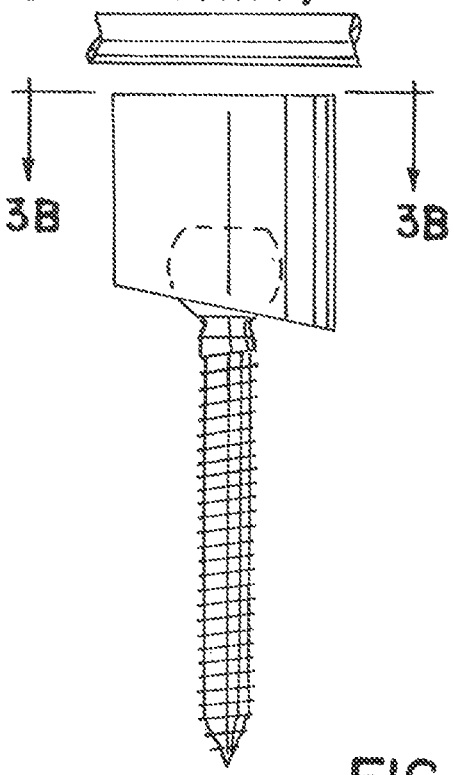

FIG-2
(PRIOR ART)

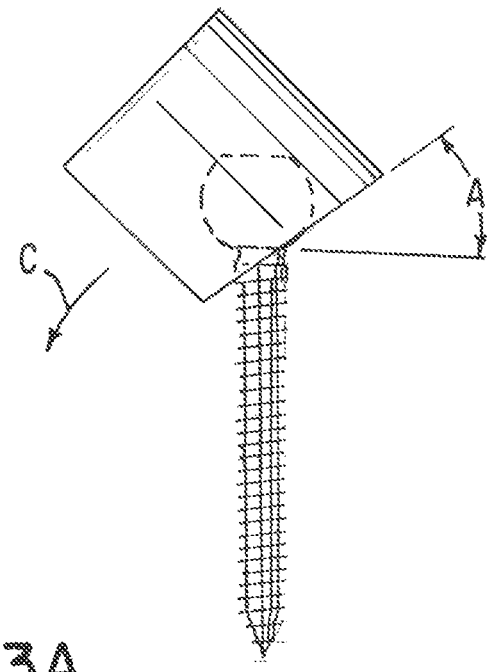

FIG-3A
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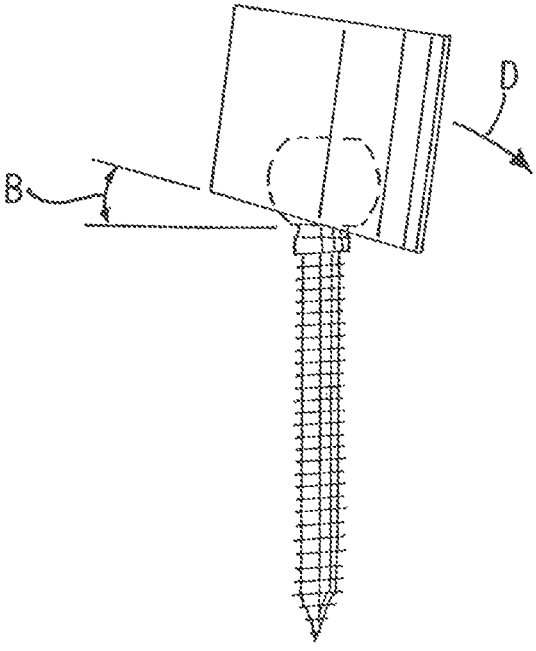

FIG-3B
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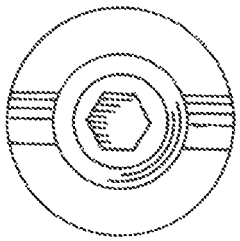


FIG-4

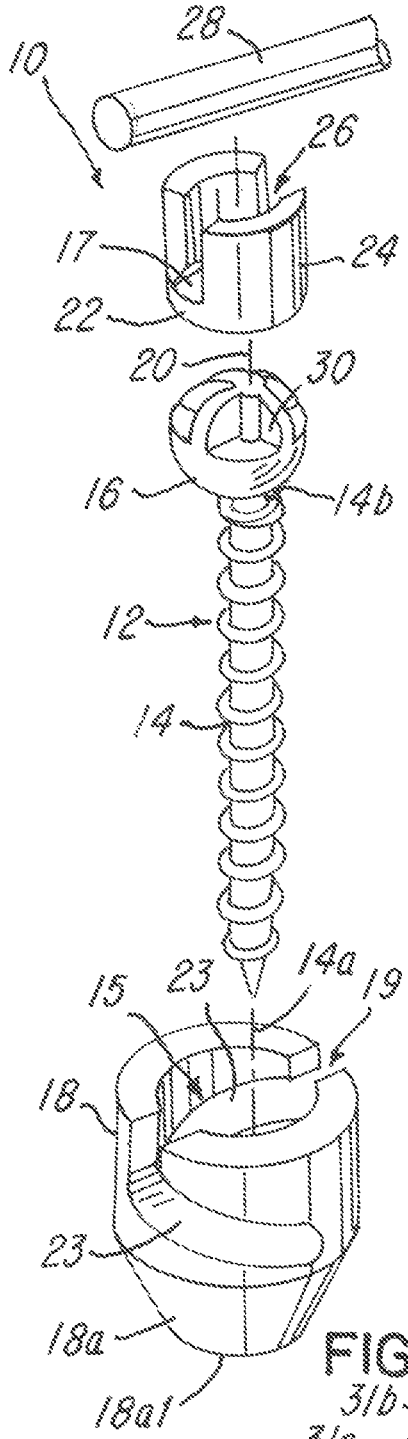


FIG-5

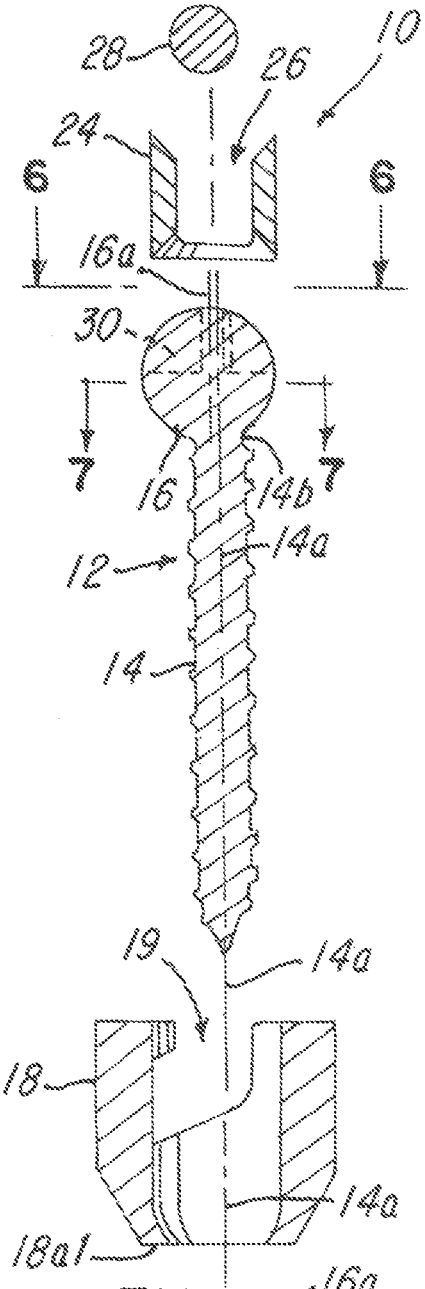


FIG-6

FIG-7

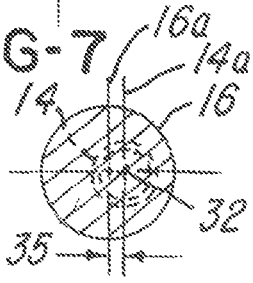


FIG-8

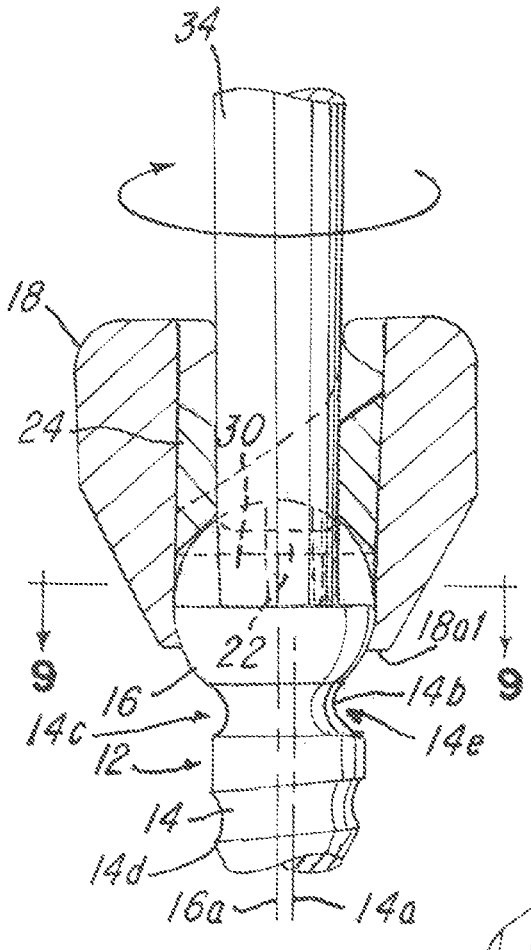


FIG-9

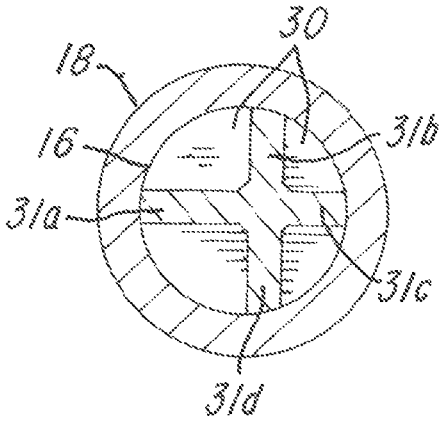


FIG-10

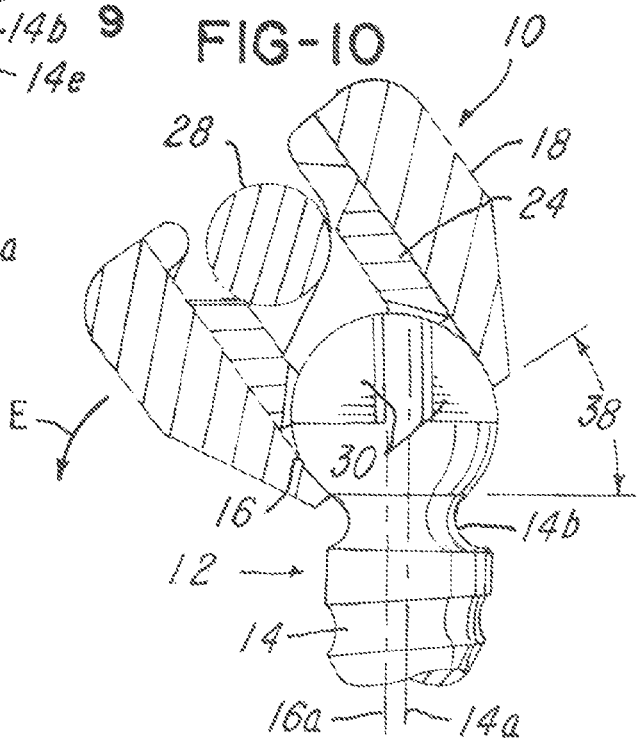


FIG-11A

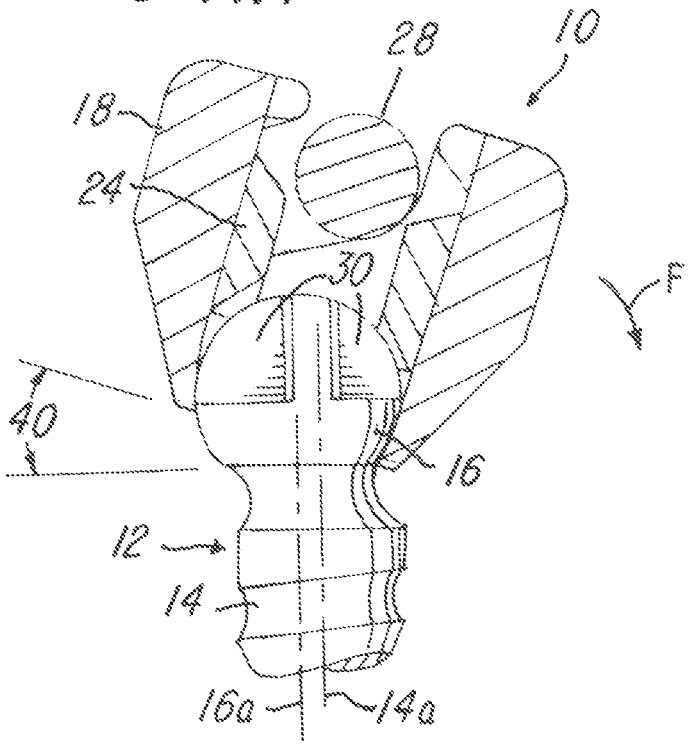
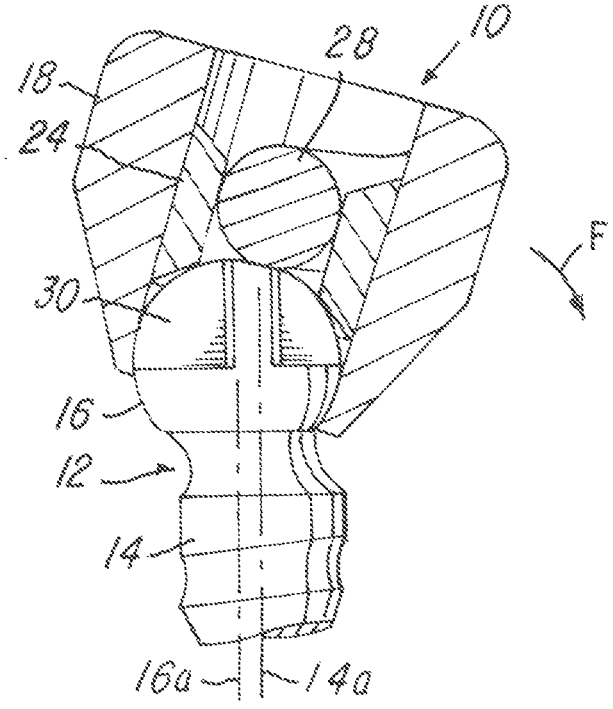


FIG-11B



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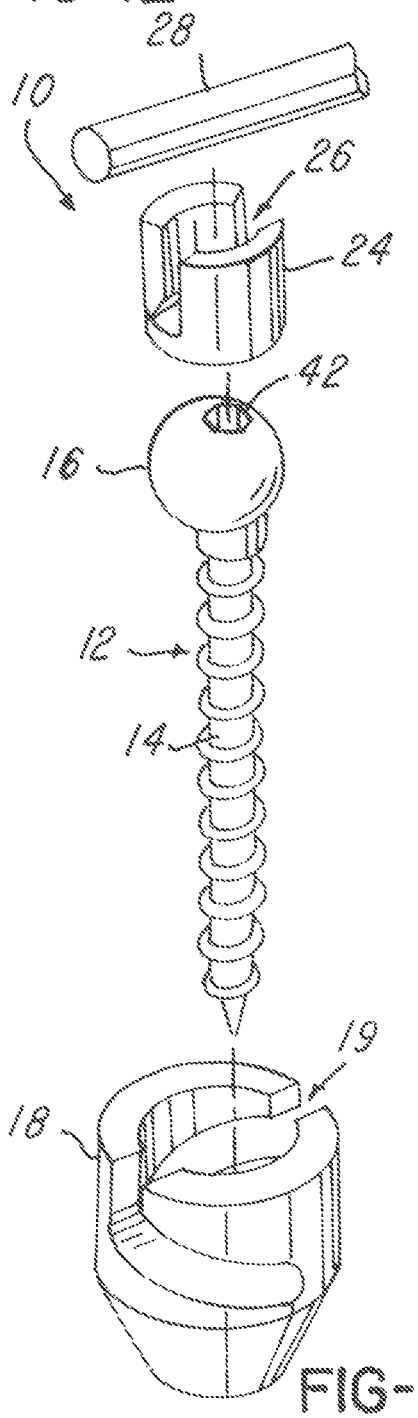


FIG-13

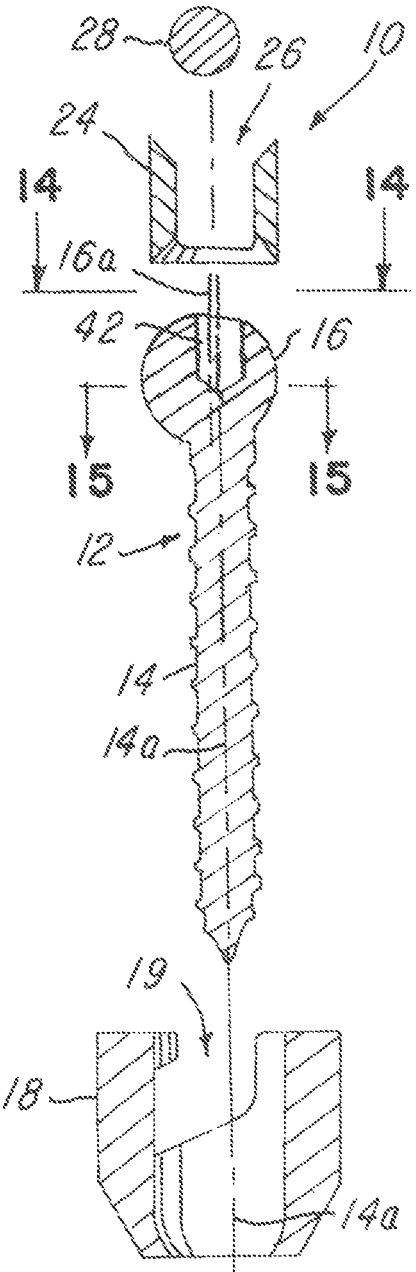


FIG-14

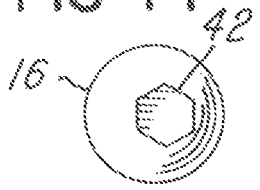


FIG-15

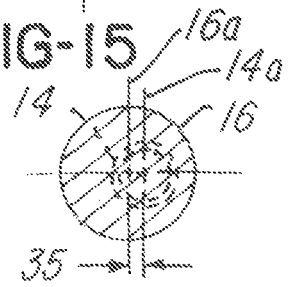


FIG-16

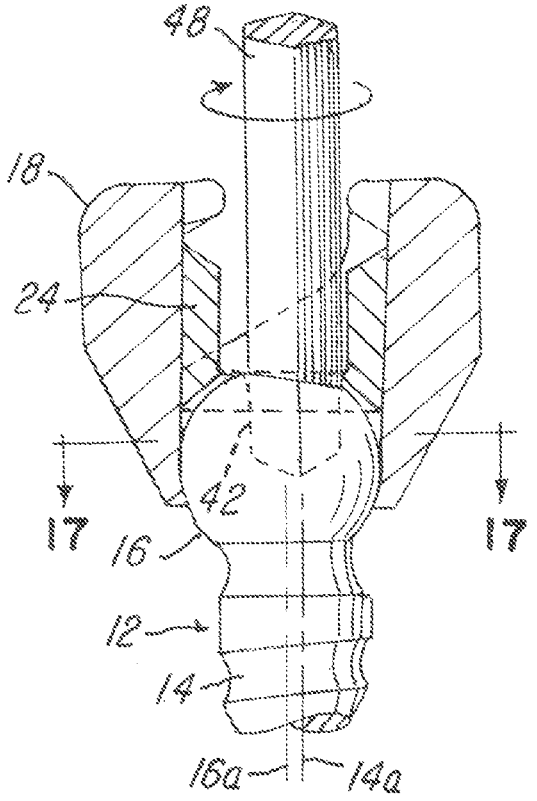


FIG-17

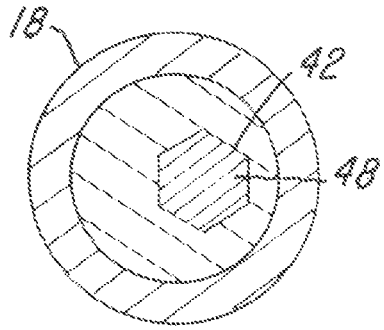


FIG-18

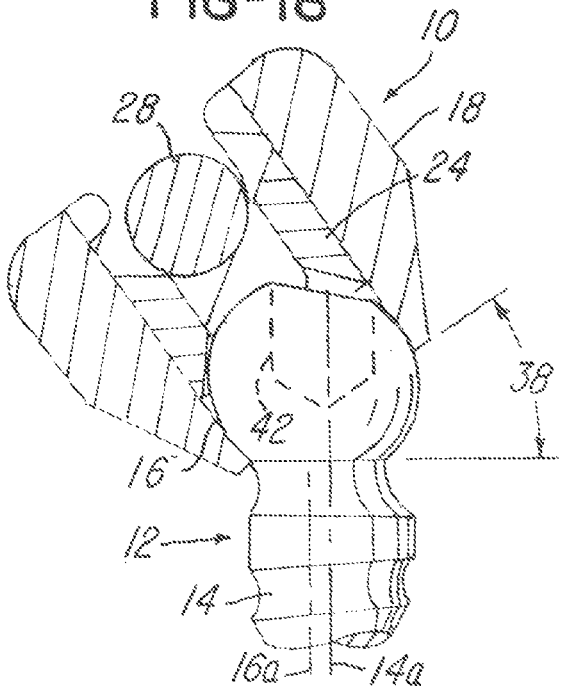


FIG-19A

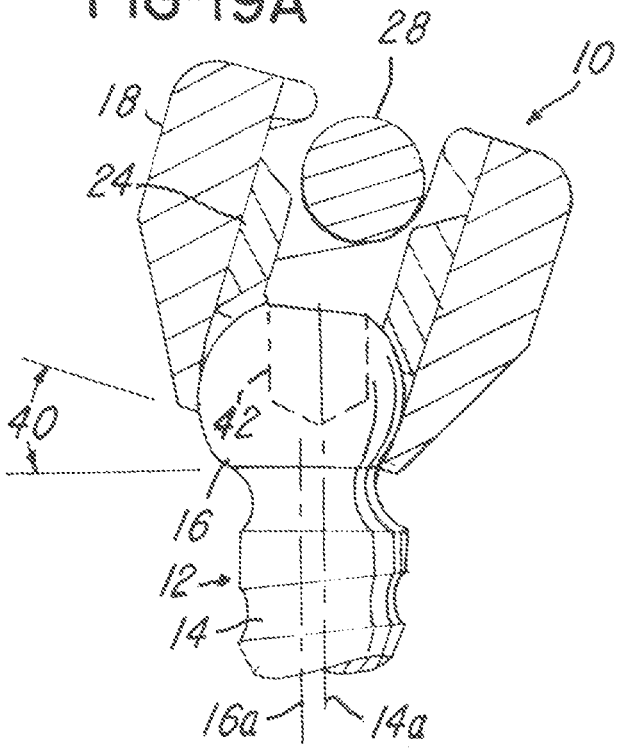


FIG-19B

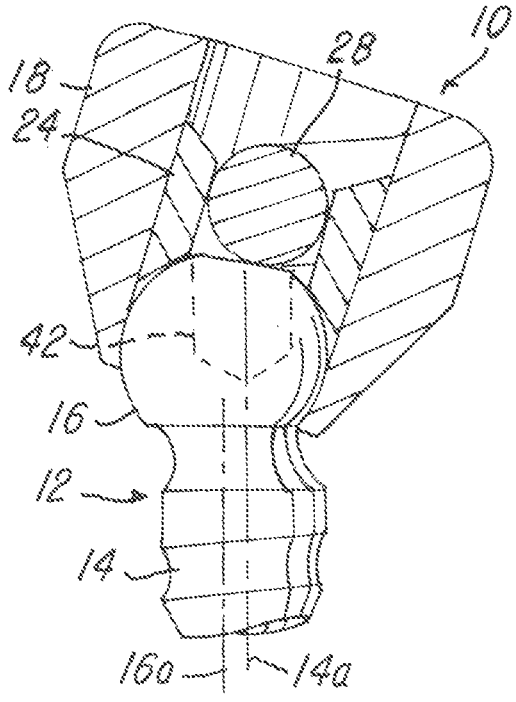
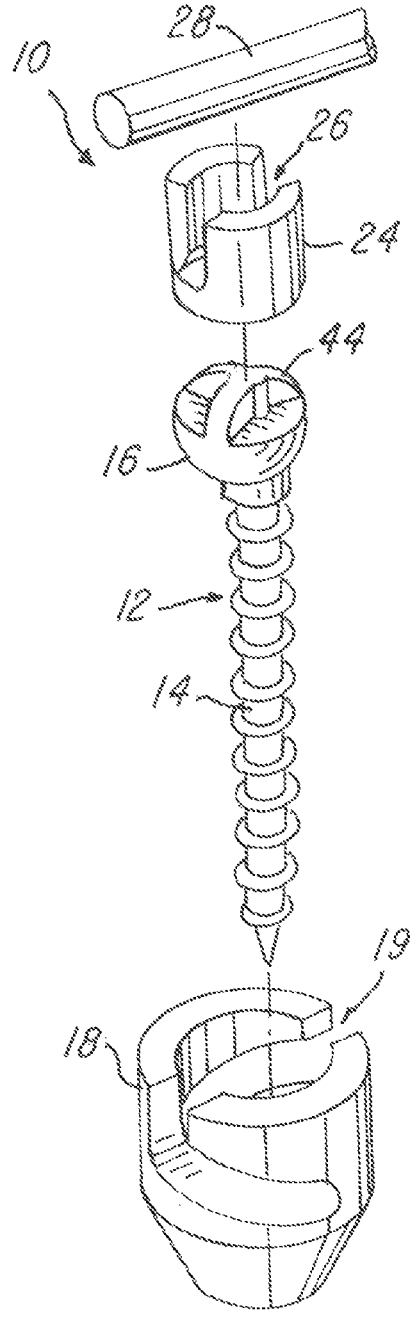


FIG-20



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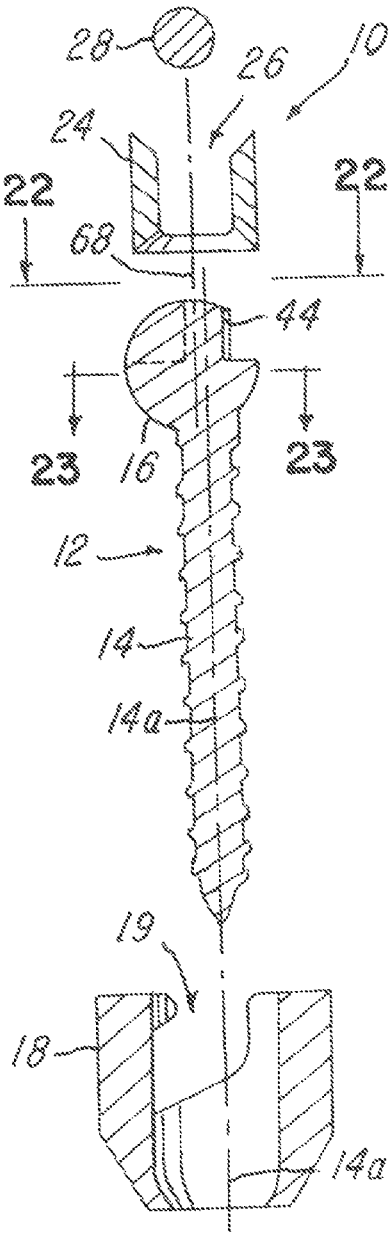

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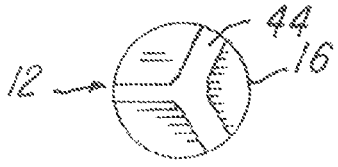

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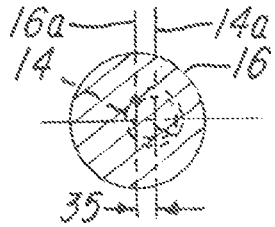

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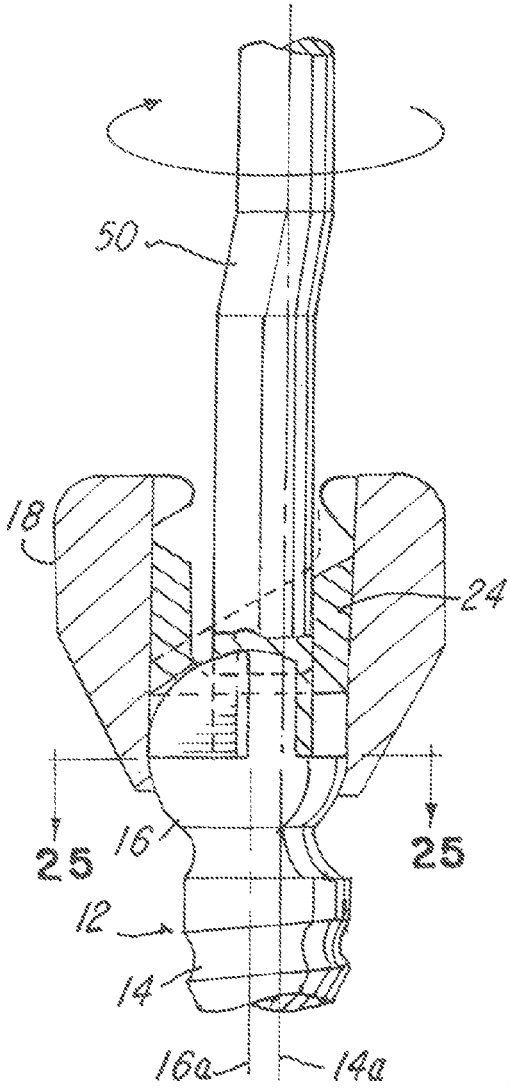

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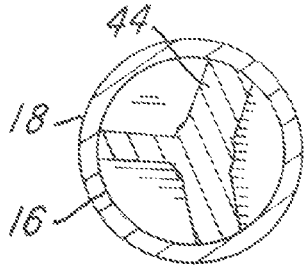


FIG-26

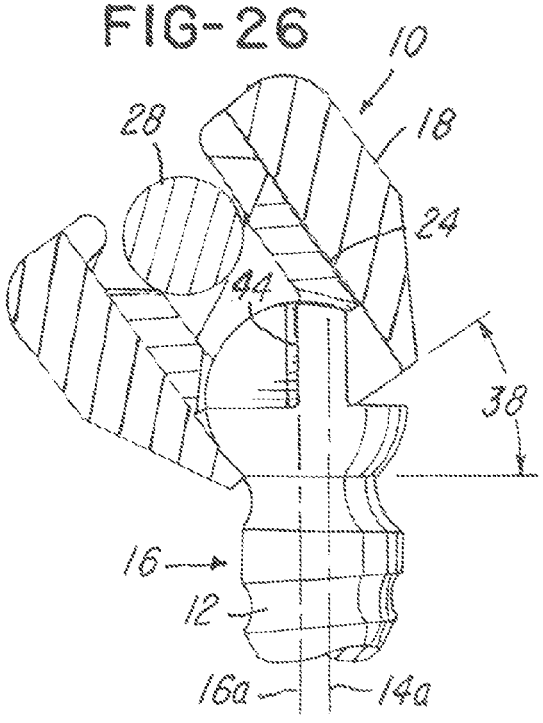


FIG-27A

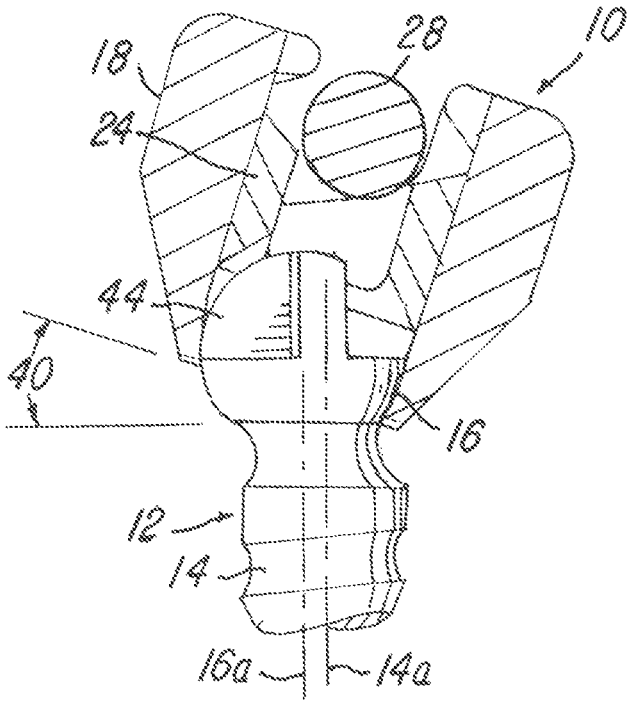


FIG-27B

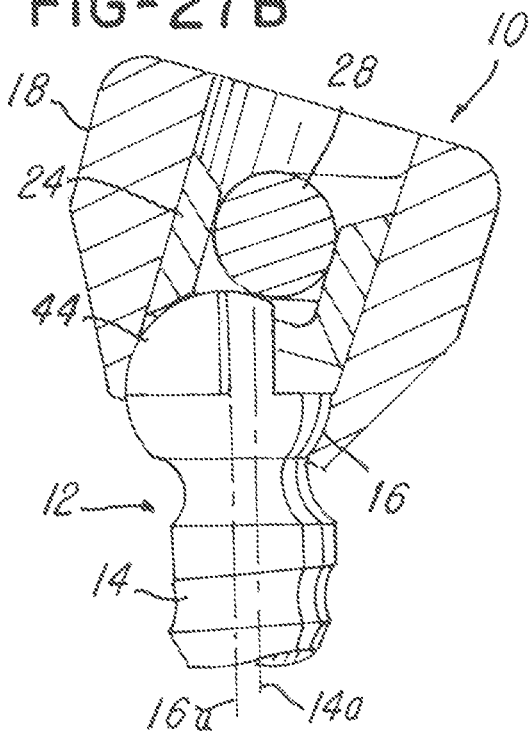
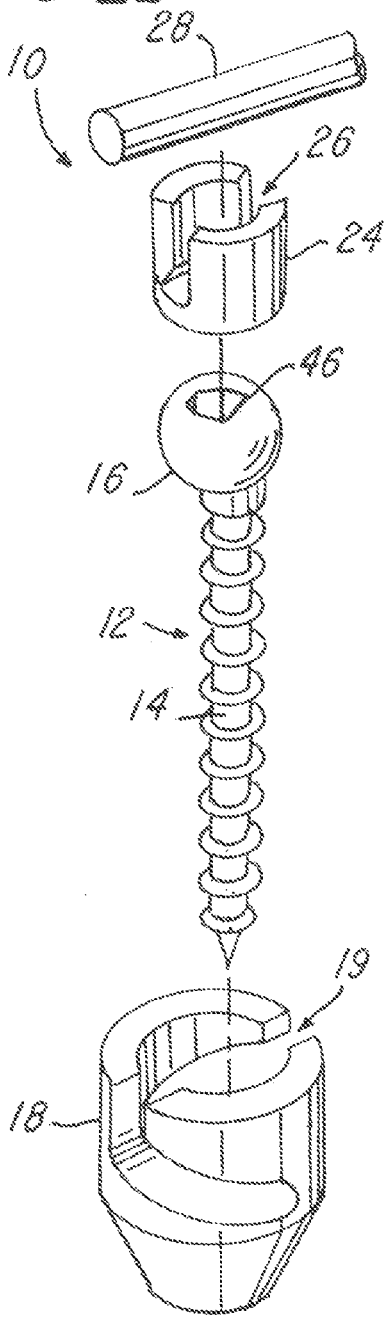


FIG-28



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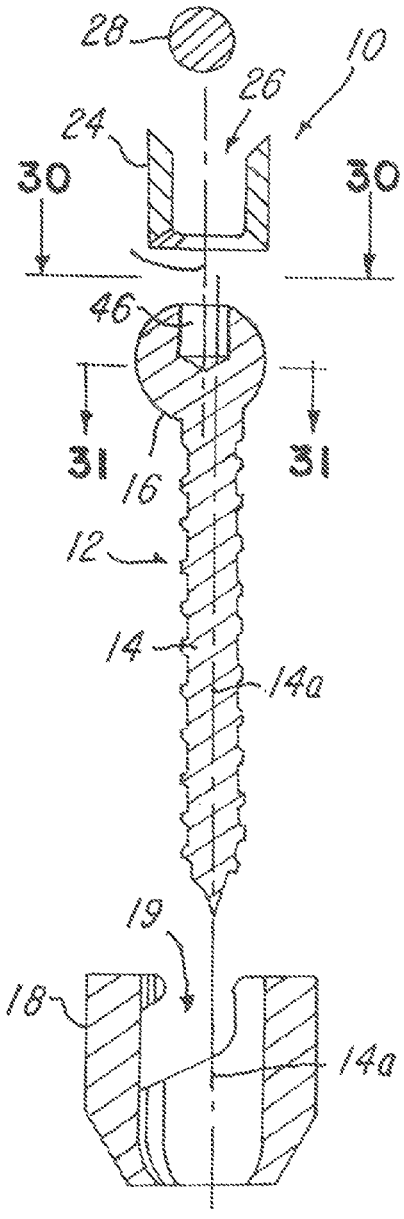

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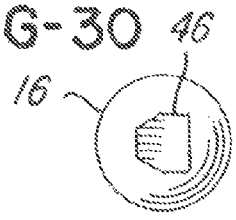
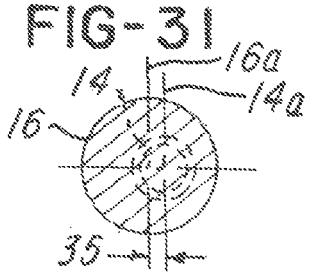


FIG-31



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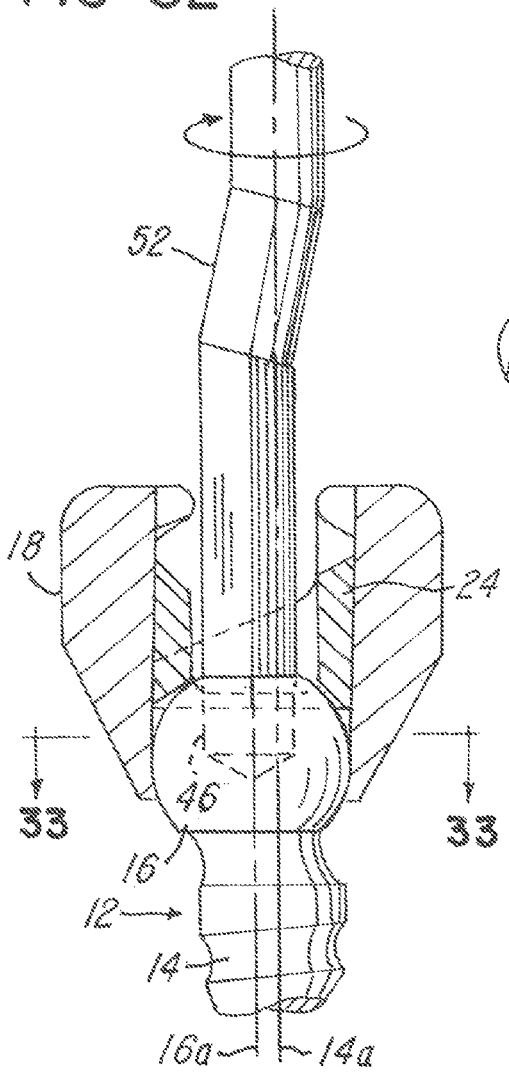


FIG-34

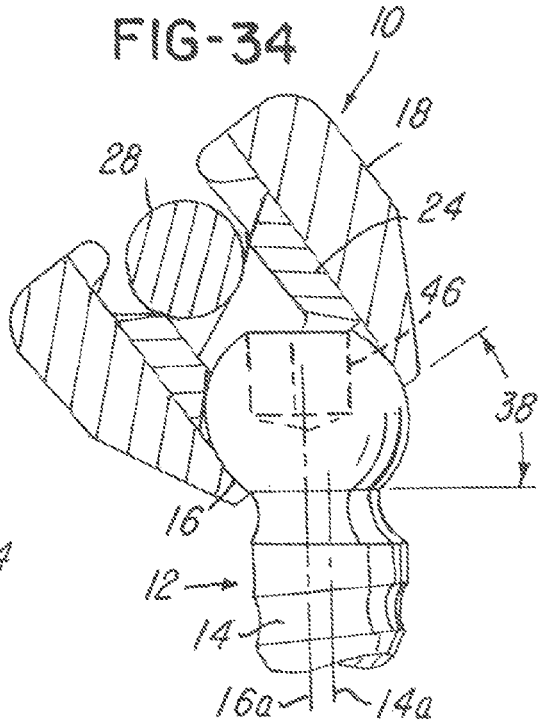


FIG-35A

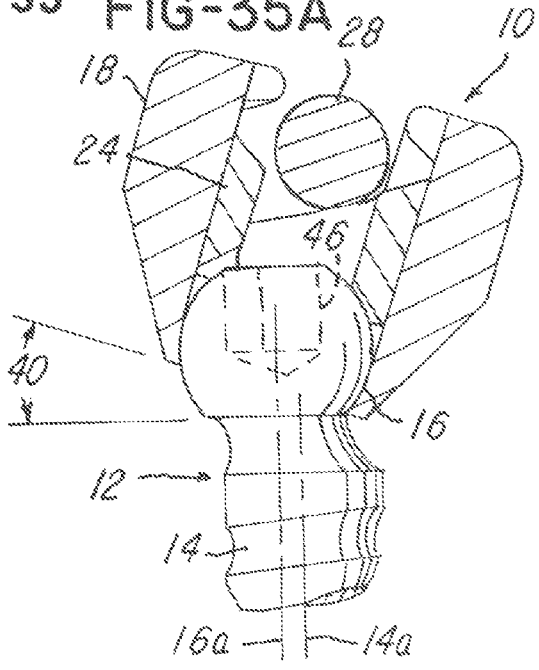


FIG-33

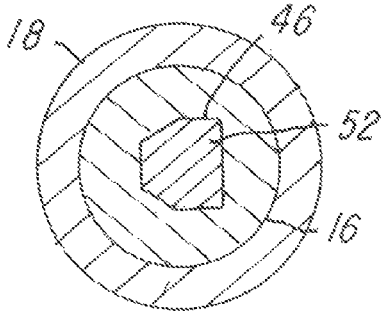


FIG-35B

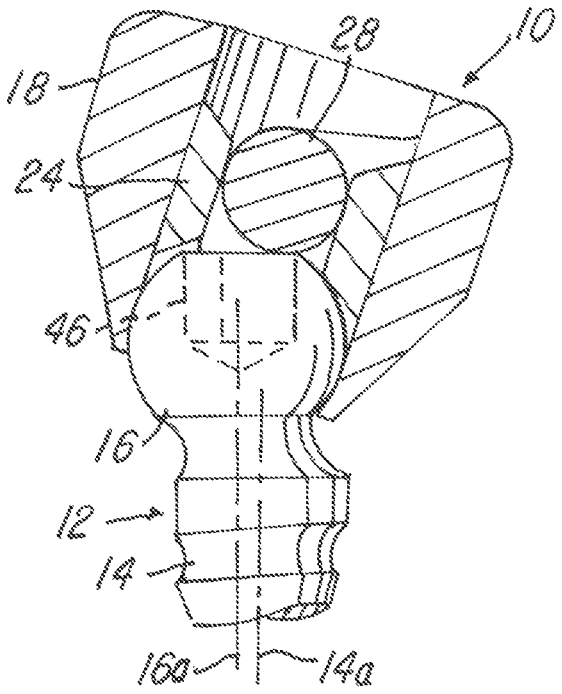


FIG-36

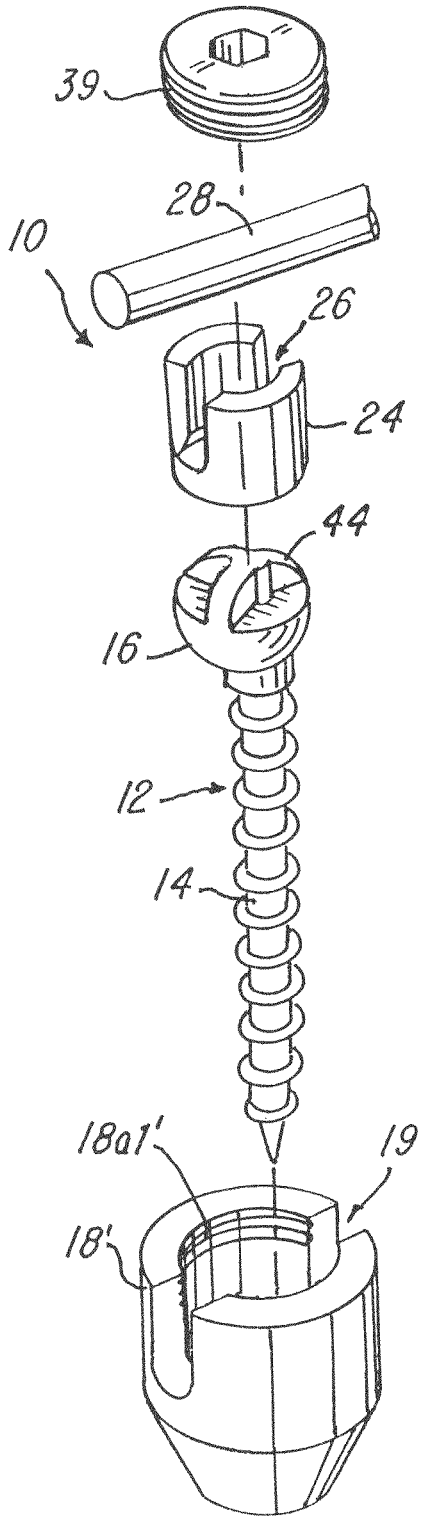

39
28
10
26
24
44
16
12
14
18a1'
19
18'

FIG-37

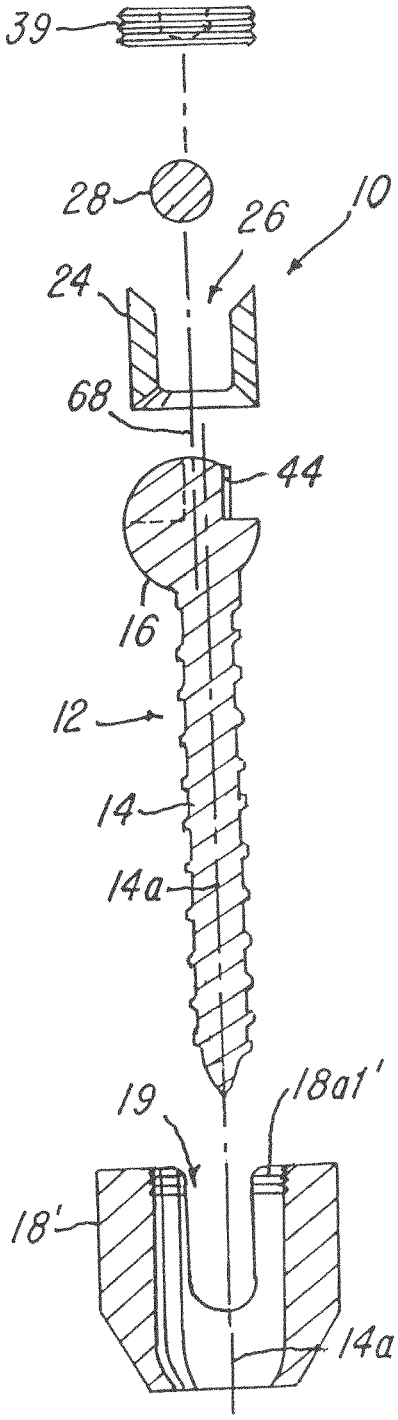

39
28
26
10
24
68
44
16
12
14
14a
19
18a1'
18'
14a

FIG-38

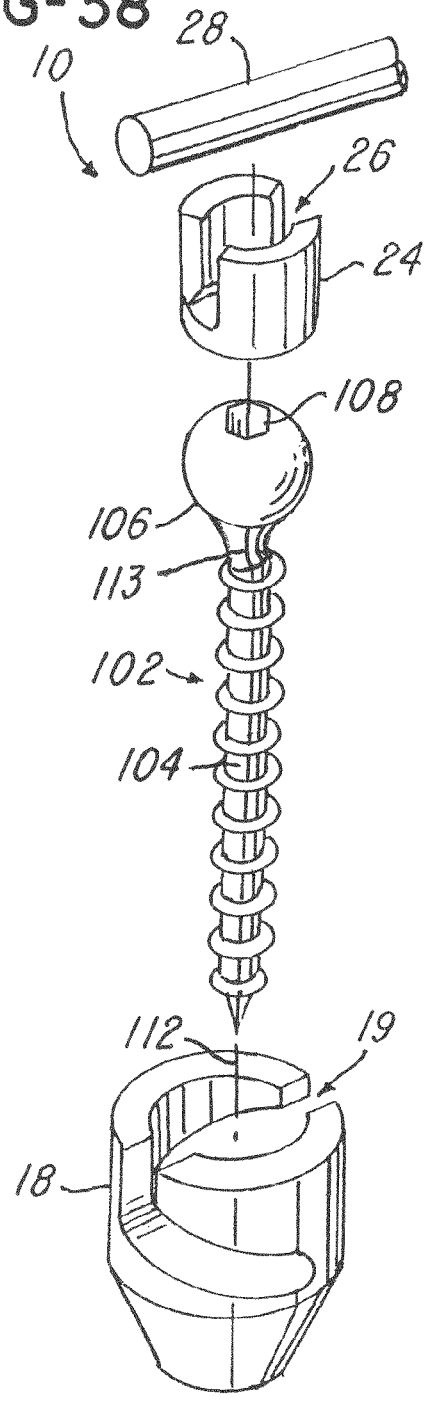


FIG-39

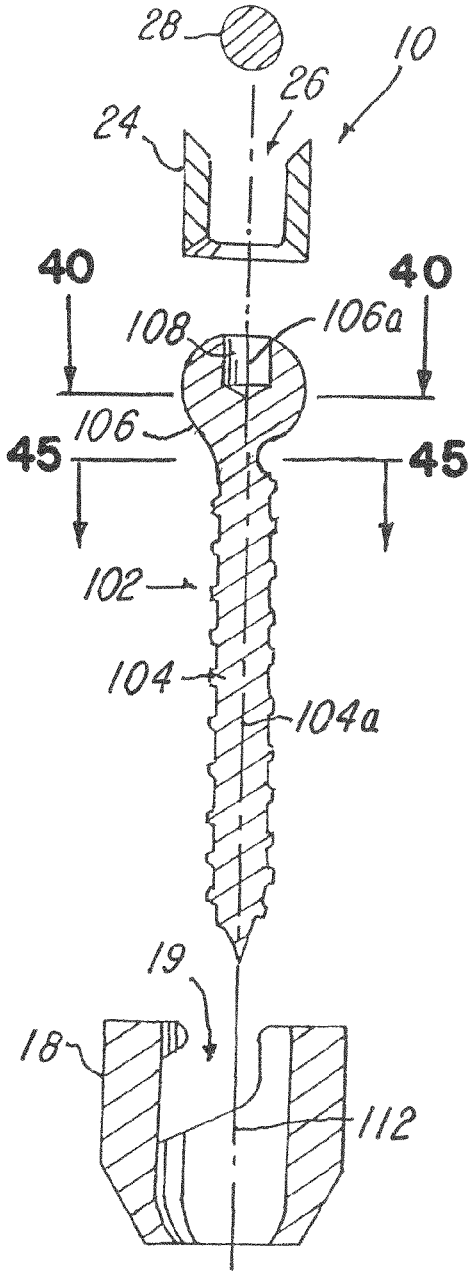


FIG-40

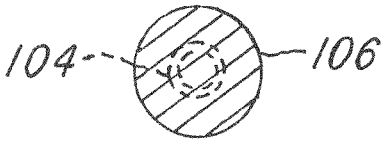


FIG-45

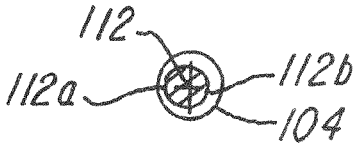


FIG-41

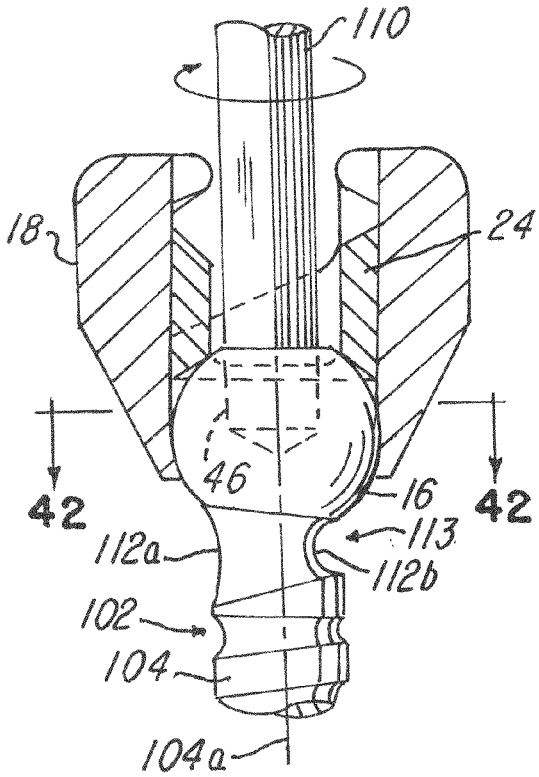


FIG-42

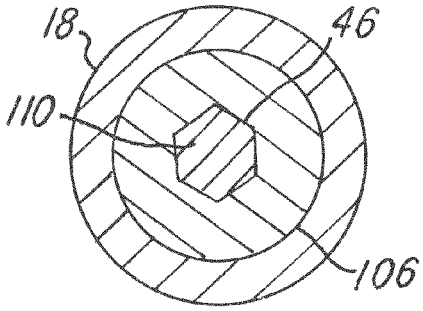


FIG-43

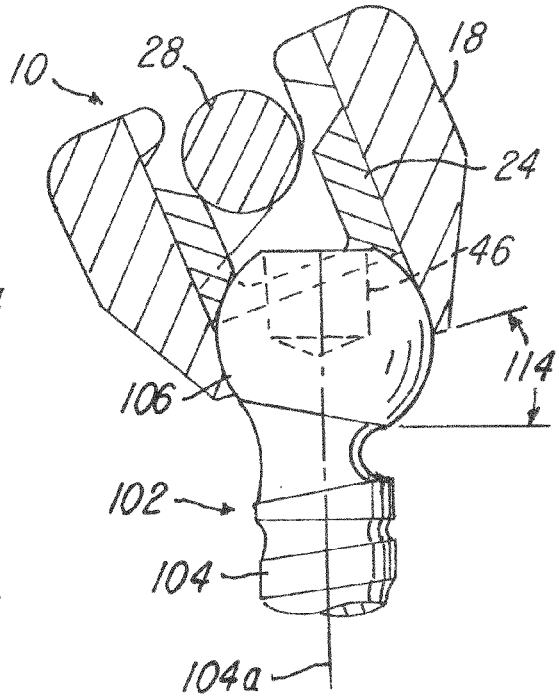
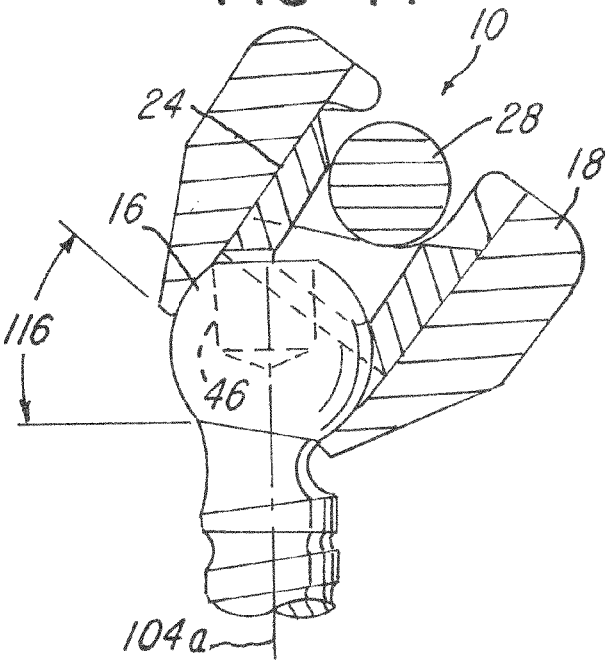


FIG-44



OFFSET MULTIAXIAL OR POLYAXIAL SCREW, SYSTEM AND ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/214,428 filed Aug. 22, 2011, which is a continuation of U.S. patent application Ser. No. 11/960,119, filed Dec. 19, 2007, now issued as U.S. Pat. No. 8,029,539, which applications are incorporated herein by reference and made a part hereof.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a screw having an offset head and to a multiaxial or polyaxial screw for use with a bone fixation system and, in particular, to a multiaxial or polyaxial screw which permits a greater range of pivotability in at least one direction.

2. Description of the Related Art

As is generally known in the art, spinal abnormalities may be correctable using a pair of posterior spinal fixation rods attached to the vertebrae using pedicle screws and the like. In order to provide increased stability and rigidity, especially to resist twisting or the like, the pair of elongated rods often include cross connecting devices. The cross connecting devices typically traverse the spinal column and couple to each of the elongated rods. In other words, the cross connecting devices are perpendicular or substantially perpendicular to the spinal column.

In addition, bone screws with a polyaxial head are commonly used in spine surgery today. They are used chiefly in the lumbar spine and screwed into bone (pedicle) posteriorly. The head of the screw is attached to the shaft of the screw. The head of the screw is machined into a ball, and the head may be provided with a receiver or socket into which the ball fits. One typical prior art system further contains a receiver for receiving a separate rod. The rod is fastened to the screw head receiver via a threaded cap. The rod is then fastened to screws placed in adjacent vertebrae thus providing stabilization. The polyaxial head allows the rod to be placed in a variety of angles with respect to the screw allowing conformance to local anatomy.

Exemplary bone screws are disclosed in the following patents: U.S. Pat. No. 5,466,237 to Bird et al.; U.S. Pat. No. 4,946,458 to Harms; U.S. Pat. No. 5,207,678 to Harms et al.; U.S. Pat. No. 5,474,555 to Puno et al.; and U.S. Pat. No. 6,869,433 to Glascott. It will be appreciated from the prior art, however, that multiaxial screws involve the ability to pivot symmetrically or the same amount in each direction. In some instances, it is desired for the retainer to be moved or pivoted about the screw head more in a certain direction than in another, whereby greater maneuverability of the rod attached to the retainer may be accommodated. It was difficult to get a "favorable angle" of the retainer relative to the screw head.

FIGS. **1**-**3**B show a prior art system wherein a retainer having an angled or canted surface that permits movement between a predetermined angle A (FIG. **2**) and a different smaller angle B (FIG. **3**A) when the retainer is moved between a first direction C and a second direction D, respectively.

Thus, it would be desirable for a multiaxial screw assembly to be developed for use with a spinal fixation system which permits non-symmetrical pivoting and that is capable of use with a variety of retainers, including those with non-canted surfaces. It would also be desirable for a multiaxial screw assembly to be developed in which simple modification of existing components enables the desired pivoting action.

SUMMARY OF THE INVENTION

It is therefore, an object of the invention to provide a polyaxial screw having a head that provides a greater range of mobility.

In one aspect, one embodiment comprises a multiaxial screw fixation system, comprising a screw having a threaded portion and a screw head portion positioned at one end thereof and a retainer having a first end, a second end opposite the first end, and a bore for receiving the threaded portion so that the screw head portion may be seated therein, wherein the screw is adapted such that the retainer is able to pivot about the screw head portion in a non-symmetrical manner.

In another aspect, another embodiment comprises a multiaxial screw fixation system, comprising a screw having a threaded portion and a screw head portion positioned at one end thereof and a retainer having a first end, a second end opposite the first end, and a bore for receiving the threaded portion so that the screw head portion may be seated therein, wherein the screw head portion comprises at least one of a partial opening or partial shape that interfaces or connects with a tool, wherein the at least one of the partial opening or the partial shape is offset from an axis of the threaded portion.

These and other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE OF THE ACCOMPANYING DRAWINGS

FIG. **1** is a front elevation view of a prior art retainer having a centered bottom edge;

FIG. **2** is a front elevation view of a prior art retainer, wherein the retainer associated therewith is shown in a first pivoted position;

FIG. **3**A is a front elevation view of the prior art retainer assembly depicted in FIGS. **1** and **2**, wherein the retainer associated therewith is shown in a second pivoted position;

FIG. **3**B is a top view of the prior art retainer taken along the line **3**B-**3**B in FIG. **1**;

FIG. **4** is an exploded perspective view of the polyaxial screw assembly having an offset head, wherein a compression member and a rod for engagement with the compression member are also shown;

FIG. **5** is an exploded side view of the polyaxial screw assembly depicted in FIG. **4**;

FIG. **6** is a top view of the polyaxial screw assembly depicted in FIGS. **4** and **5** taken along line **6**-**6** in FIG. **5**;

FIG. **7** is a top sectional view of the polyaxial screw assembly depicted in FIGS. **4**-**6** taken along line **7**-**7** in FIG. **5**;

FIG. **8** is an enlarged, partial sectional view of the polyaxial screw assembly depicted in FIGS. **4** and **5**, wherein a tool is shown as interfacing with a head portion thereof to position it within the retainer;

FIG. **9** is a top sectional view of the polyaxial screw assembly with the head portion thereof positioned within the retainer, as depicted in FIG. **8**, taken along line **9**-**9** of FIG. **8**;

FIG. **10** is an enlarged, partial sectional view of the polyaxial screw assembly depicted in FIG. **8**, wherein the compression member and rod engaged therewith are included and the retainer has been pivoted to a maximum degree in a first direction;

FIGS. **11**A and **11**B are enlarged, partial sectional views of the polyaxial screw assembly depicted in FIG. **8**, wherein the compression member and rod in unlocked and locked positions and the retainer has been pivoted to a maximum degree in a second direction;

FIG. **12** is an exploded perspective view of a polyaxial screw assembly having a first alternative configuration, wherein a compression member and a rod for engagement with the compression member are also shown;

FIG. **13** is an exploded side view of the polyaxial screw assembly depicted in FIG. **12**;

FIG. **14** is a top view of the polyaxial screw assembly depicted in FIGS. **12** and **13** taken along line **14-14** in FIG. **13**,

FIG. **15** is a top sectional view of the polyaxial screw assembly depicted in FIGS. **12** and **13** taken along line **15-15** in FIG. **13**;

FIG. **16** is an enlarged, partial sectional view of the polyaxial screw assembly depicted in FIGS. **12** and **13**, wherein a tool is shown as interfacing with a head portion thereof to position it within the retainer;

FIG. **17** is a top section view of the polyaxial screw assembly with the head portion thereof positioned within the retainer, as depicted in FIG. **26**, taken along line **17-17** of FIG. **16**;

FIG. **18** is an enlarged, partial sectional view of the polyaxial screw assembly depicted in FIG. **16**, wherein the compression member and rod engaged therewith are included and the retainer has been pivoted to a maximum degree in a first direction;

FIGS. **19**A and **19**B are enlarged, partial sectional views of the polyaxial screw assembly depicted in FIG. **16**, wherein the compression member and rod in unlocked and locked positions and the retainer has been pivoted to a maximum degree in a second direction;

FIG. **20** is an exploded perspective view of a polyaxial screw assembly having a second alternative configuration, wherein a compression member and a rod for engagement with the compression member are also shown;

FIG. **21** is an exploded side view of the polyaxial screw assembly depicted in FIG. **20**;

FIG. **22** is a top view of the polyaxial screw assembly depicted in FIGS. **20** and **21** taken along line **22-22** in FIG. **21**,

FIG. **23** is a top sectional view of the polyaxial screw assembly depicted in FIGS. **20** and **21** taken along line **23-23** in FIG. **21**;

FIG. **24** is an enlarged, partial sectional view of the polyaxial screw assembly depicted in FIGS. **20** and **21**, wherein a tool is shown as interfacing with a head portion thereof to position it within the retainer;

FIG. **25** is a top section view of the polyaxial screw assembly with the head portion thereof positioned within the retainer, as depicted in FIG. **24**, taken along line **25-25** of FIG. **24**;

FIG. **26** is an enlarged, partial sectional view of the polyaxial screw assembly depicted in FIG. **24**, wherein the compression member and rod engaged therewith are included and the retainer has been pivoted to a maximum degree in a first direction;

FIGS. **27**A and **27**B are enlarged, partial sectional views of the polyaxial screw assembly depicted in FIG. **24**, wherein the compression member and rod in unlocked and locked positions;

FIG. **28** is an exploded perspective view of a polyaxial screw assembly having a third alternative configuration, wherein a compression member and a rod for engagement with the compression member are also shown;

FIG. **29** is an exploded side view of the polyaxial screw assembly depicted in FIG. **28**;

FIG. **30** is a top view of the polyaxial screw assembly depicted in FIGS. **28** and **29** taken along line **30-30** in FIG. **29**,

FIG. **31** is a top sectional view of the polyaxial screw assembly depicted in FIGS. **28** and **29** taken along line **31-31** in FIG. **29**;

FIG. **32** is an enlarged, partial sectional view of the polyaxial screw assembly depicted in FIGS. **28** and **29**, wherein a tool is shown as interfacing with a head portion thereof to position it within the retainer;

FIG. **33** is a top sectional view of the polyaxial screw assembly with the head portion thereof positioned within the retainer, as depicted in FIG. **32**, taken along line **33-33** of FIG. **32**;

FIG. **34** is an enlarged, partial sectional view of the polyaxial screw assembly depicted in FIG. **32**, wherein the compression member and rod engaged therewith are included and the retainer has been pivoted to a maximum degree in a first direction;

FIGS. **35**A and **35**B are enlarged, partial sectional view of the polyaxial screw assembly depicted in FIG. **32**, wherein the compression member and rod engaged therewith in unlocked and locked positions;

FIG. **36** is an exploded view of another embodiment of the invention illustrating the polyaxial screw assembly used in combination with a retainer that utilizes a cap, such as a thread cap;

FIG. **37** is a sectional exploded view of the embodiment shown in FIG. **36**;

FIG. **38** is a view of another embodiment of the invention wherein a screw head has a common or coaxial axis with the shank;

FIG. **39** is a sectional view of the embodiment shown in FIG. **38**;

FIG. **40** is a sectional view taken along the line **40-40** in FIG. **39**;

FIG. **41** is a fragmentary sectional view of the embodiment shown in FIG. **39** illustrating the use of a tool that becomes coaxial with the axes and shank;

FIG. **42** is a sectional view taken along the line **42-42** in FIG. **41**;

FIG. **43** is a fragmentary sectional view of the embodiment shown in FIG. **38** illustrating the pivotal movement of the retainer relative to the head, with the retainer being in an unlocked position;

FIG. **44** is another fragmentary sectional view of the embodiment shown in FIG. **38** illustrating the pivotal movement of the head in a direction that is different from the direction shown in FIG. **43**, but illustrating a greater degree of pivoting; and

FIG. **45** is a sectional view of an intermediate portion showing its eccentricity and non-symmetry about an axis.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, wherein identical numerals indicate the same elements throughout the figures, FIGS. **4-35**B depict various embodiments of a multi-axial screw and spinal fixation assembly **10**. Spinal fixation assembly **10** includes a screw **12** having a threaded portion **14** and a screw head **16** that preferably has a rounded, arcuate, spherical or curved profile. Spinal fixation assembly **10** further includes a retainer **18**, which preferably has a generally cylindrical configuration. In these illustrative embodiments, the retainer **18** is capless, but the retainer **18** could be non-cap-

less, such as is illustrated in FIGS. **36** and **37** below. Although not shown, it will be appreciated that retainer **18** includes an aperture or bore **15** therethrough along a centerline axis **20** (FIG. **4**). Accordingly, the bore **15** that receives a threaded portion **14** of the screw **12** until screw head **16** thereof is received adjacent a first end **18***a* of retainer **18**. It will be understood that screw head **16** may be positioned within retainer **18** in any known manner so that multiaxial or polyaxial and relative movement between retainer **18** and screw **12** is permitted. In this way, a user, such as a surgeon or physician, is able to change the polyaxial position of retainer **18** relative to screw **12** in order to adjust an angular position of the retainer or receiving channel **19** and an elongated member or rod, such as rod **28** (FIG. **6**), which is received and retained in the retainer **18** at a first end **18***a*.

Contrary to similar assemblies in the prior art shown in FIGS. **1-3**B, screw **12** is configured so that the retainer **18** is able to pivot in a non-symmetrical manner about screw head **16**. More specifically, it will be noted from the embodiment shown in FIGS. **10**, **11**A-**11**B, **18**, **19**A-**19**B, **26**, **27**A-**27**B, **34** and **35**A-**35**B, that a centerline axis **16***a* of screw head **16** is offset from a centerline axis **14***a* of the threaded portion **14**. The screw head **16** enables the retainer **18** to pivot by varying degrees in different directions. In this way, implementation of spinal fixation assembly **10** will permit a greater degree of movement of the retainer **18** toward the threaded portion **14**, which may be desirable for a given application or case.

In the illustration, the retainer **18** which preferably has a generally cylindrical configuration with helical rod-receiving channels **21** and **23** (FIG. **4**) similar to that described in detail in U.S. Patent Application Publication 2007/0043357 A1 to Kirschman U.S. patent application Ser. No. 11/193,523 filed Jul. 29, 2005; U.S. patent application Ser. No. 11/610,698 filed Dec. 14, 2006; and U.S. patent application Ser. No. 11/762,911 filed Jun. 14, 2007, which are also owned by the assignee of the present application and all of which are incorporated by reference and made a part hereof.

It will be appreciated that retainer **18** preferably includes a receiving channel **19** in communication with the helical rod-receiving channels **21** and **23** for engaging an elongated rod or member **28**. In one embodiment, the rod **28** may engage directly against the screw head **16**.

The spinal fixation assembly **10** may further include a compression member **24** that is received in the bore **15**. The compression member **24** comprises a receiving channel **26** which is utilized to receive engage rod **28** and which engages the screw head **16**.

As mentioned earlier, the screw **12** may be used with a non-capless retainer **18**, such as retainer **18'** in FIGS. **36** and **37**, which utilizes a cap or other means for retaining rod **28** in the retainer.

While a centerline axis **14***a* through threaded portion **14** of screw **12** remains generally aligned with a centerline axis **16***a* through retainer **18**, it will be appreciated that a centerline axis **16***a* through screw head **16**, however, is generally offset from and not coaxial with centerline axes **14***a* and **16***a*. As such, screw head **16** may either be rotated so that centerline axis thereof is at a specified angle relative to centerline axes **14***a* and **16***a* or shifted in parallel to such centerline axes **14***a* and **16***a*. In either case, it will be understood that screw head **16** is not configured or oriented so as to be symmetrical with respect to or about the centerline axes **14***a* and **16***a*.

Screw head **16** preferably includes at least one female opening, slot or groove **30** (FIG. **4**) so that a corresponding tool **34** is able to interact with screw **12** in order to threadingly screw the screw **12** into spinal bone. The opening **30** to be formed therein for receiving the corresponding tool **34** which enables screw **12** to be threaded into and out spinal bone. As best seen in FIGS. **6** and **9**, the partial opening is configured as walls **31***a*, **31***b*, **31***c* and **31***d* that intersect at point **32** and that define recessed areas or slots **30** formed in screw head **16** (i.e., as for a Phillips screw). More specifically, the walls **31***a*, **31***b*, **31***c* and **31***d* define opening **30** in screw head **16**. Note that the intersecting point **32** is aligned with centerline axis **14***a* of threaded portion **14** or a distance **35** (FIG. **7**) from centerline axis **16***a*. In this way, the tool **34** (FIG. **8**) is able to access the screw head **16** and slots **30** and pressure applied thereby is directed along centerline axis **14***a*.

When screw head **16** is seated properly within retainer **18**, as viewed for example in FIGS. **8**, **10** and **11**, it will be appreciated that the intentional misalignment of screw head **16** and threaded portion **14** creates the ability for retainer **18** (and compression member **24**) to pivot non-symmetrically. For example, FIG. **10** depicts the pivoting of retainer **18** about screw head **16** in a first direction E as an angle **38** with a range of, for example, approximately 0°-55°. Similarly, FIG. **11**A shows the pivoting of retainer **18** about screw head **16** in a second direction F (opposite the first direction), where an angle **40** has a range of, for example, approximately 0°-55°. Clearly, the maximum amount of movement or pivoting is greater in the first direction E than in the second direction F. This permits a desirable flexibility for the adjustment of rod **28** when secured as part of a spinal fixation assembly.

FIG. **11**B shows the rod **28** in a loaded and locked position after the retainer **18** has been pivoted and rotated to the locked position.

It will be understood that the partial opening or partial shape of the screw head **16** and the corresponding tool or driver utilized to interface therewith may take any desirable form. Besides the exemplary slots **30** and tool **34** shown in FIGS. **6**, **8** and **9**, other possible configurations of the screw head **16** include, but are not limited to a shape adapted to define a hexagonal opening **42** (FIGS. **14** and **17**), a "Y" shape **44** (FIGS. **22** and **25**), and an opening **46** defined by a plurality of side walls (FIGS. **30** and **33**). Of course, corresponding tools **48** (FIG. **16**), **50** (FIG. **24**) and **52** (FIG. **32**) would be utilized therewith, respectively. It will be appreciated that the respective tool may have a linear configuration (as evidenced by tools **34** and **48**) or a non-linear configuration (as seen for tools **50** and **52**).

Moreover, the embodiments of FIGS. **4-35**B illustrate use of the screw **12** with the compression module **17**, but it should be understood that the screw **12** may be used with retainers that do not utilize a compression module **17**. It should be understood that while the embodiments illustrated in FIGS. **4-35**B illustrate the use of the screw **12** with a capless retainer and compression module **17**, the screw **12** may be used with non-capless systems. For example, FIGS. **36** and **37** illustrate the use of the screw **12** with a non-capless retainer **18'**. In this embodiment, retainer **18'** has a threaded interior surface for receiving a threaded cap **39**. Of course, the screw **12** may also be used with other types of retainers that utilize other means for retaining the rod in the receiver, and such receivers and securing mechanisms are known to those skilled in the art.

Referring now to FIGS. **38-44**, another embodiment is shown. In this embodiment, those parts that are the same or similar to the part shown in FIGS. **4-35**B are identified with the same part number.

As shown in FIGS. **38** and **39**, notice that this embodiment utilizes a screw **102** having a threaded shank **104** and a head **106**. The head **106** comprises a female aperture **108** for receiving a tool for screwing the screw **102**. In the illustration being described, and as illustrated in FIG. **41**, the tool **110** may be a linear tool, without an offset of the type illustrated in

FIG. **24**, for example. Notice that in this embodiment, the retainer **18** comprises an axis **112** that is coaxial with the axis **104***a* of the shank **104**. Notice also that the head **106** comprises an axis **106***a* that is coaxial with both the axis **104***a* of shank **104** and the axis **112** as illustrated in FIG. **39**. This is advantageous in that when the screw **102** is rotatably driven, it may be driven along a common axis which facilitates mounting or screwing the screw **102** into bone.

As best illustrated in FIGS. **38** and **39**, notice that the head **106** is integrally secured to the shank **104** by an intermediate or neck portion **113**. As shown in FIGS. **41-43** and **44**, notice that the neck portion **113** comprises a first surface or area **112***a* having a relatively large radius and a second surface or area **112***b* that has a relative small radius as shown. The larger and small radiuses of the surfaces **112***a* and **112***b* permit the retainer **18** to be pivoted a plurality of different angles or degrees. For example, FIG. **43** illustrates the retainer **18** pivoting to the left (as viewed in FIG. **43**) a predetermined angle **114** as shown. In contrast, notice in FIG. **44**, the relatively small radius surface **112***b* defines an area or intermediate portion **113** that permits the retainer **18** to pivot toward the right (as viewed in FIG. **44**) a predetermined angle **116** which is greater than the predetermined angle **114** as in at least one area of the intermediate portion **113**.

To enable the polyaxial movement, notice in FIG. **41** that the intermediate portion **113** is neither centric nor symmetrical about the axis **104***a*. Thus, the intermediate portion **113** is eccentric about axis **104***a*. Notice in FIGS. **38-45** that the radius of curvature is not constant about the axis **104***a* and generally becomes larger as the radius of curvature moves from the portion or area **112***b* toward the area **112***a*, with the area **112***a* having the largest radius of curvature. Thus, not only is the intermediate portion **113** not symmetrical about the axis **104***a*, but the radius of curvature changes as well.

This embodiment enables the system of FIGS. **38-45** to enable the retainer **18** to pivot a plurality of angles about the head **106**, with the greatest degree of pivot being realized when the retainer **18** pivots toward the smallest radius of curvature **112***b* and the smallest amount of pivot being achieved when the retainer **18** is pivoted toward the largest radius of curvature **112***a*. Thus, the embodiment of FIGS. **38-45** enables the retainer **18** to pivot a plurality of different angles about the head **106** as shown.

Another advantage of the embodiment illustrated in FIGS. **38-44** is that it enables the use of the tool **110** that is generally linear and that is not offset as illustrated, for example, in the embodiment shown in FIG. **24**. This facilitates enabling the tool **110** to become coaxial with the axes of the head **106** and shank **104**, as illustrated in FIG. **41**, which facilitates rotating the screw **102** and mounting in into bone.

FIG. **42** shows a cross-section of the illustration shown in FIG. **41** illustrating the tool **110** being coaxial with the head **106** as shown.

Note also that an intersection of the screw head **16** to the threaded portion **14** may have a wall **14***b* (FIGS. **5** and **8**) that defines an area **14***c* that is generally concave and permits a bottom edge **18***a***1** (FIGS. **4**, **5** and **8**) of retainer **18** to move inwardly toward centerline axis **14***a* and inside an imaginary plane defined by the outside edge **14***d* (FIG. **8**) of at least one thread on the threaded portion **14**.

Having shown and described the preferred embodiment of the present invention, further adaptations of the capless multiaxial screw can be accomplished by appropriate modifications by one of ordinary skill in the art without departing from the scope of the invention.

While the system and method herein described constitute preferred embodiments of this invention, it is to be understood that the invention is not limited to this precise system and method, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A multiaxial screw fixation system, comprising:

(a) a screw having a threaded portion and a screw head portion positioned at one end thereof; and

(b) a retainer having a first end, a second end opposite said first end, and a bore for receiving said threaded portion so that said screw head portion may be seated therein, said retainer further comprising a retainer rod-receiving channel and having a retainer centerline axis;

wherein said threaded portion comprises a screw centerline axis, said screw centerline axis being offset from said retainer centerline axis when said screw centerline axis and said retainer centerline axis are parallel;

wherein said retainer can pivot about said screw head portion a greater degree in a first direction compared to a second direction so that a maximum amount of pivoting in said first direction is greater than in said second direction.

2. The multiaxial screw fixation system of claim **1**, wherein a tool has an offset for driving said screw.

3. The multiaxial screw fixation system of claim **2**, wherein said screw head has a partial opening formed therein for receiving a tool.

4. The multiaxial screw fixation system of claim **3**, wherein said partial opening is a hex opening.

5. The multiaxial screw fixation system of claim **3** wherein a centerpoint of said partial opening is offset from a second centerline axis of said threaded portion.

6. The multiaxial screw fixation system of claim **1**, wherein a centerpoint of a partial opening is aligned with a first centerline axis of said screw head portion.

7. The multiaxial screw fixation system of claim **1**, wherein said screw head has a partial shape formed therein for receiving a tool.

8. The multiaxial screw fixation system of claim **7** wherein said partial shape is a Y-shape.

9. The multiaxial screw fixation system of claim **7** wherein a centerpoint of said partial shape is offset from a centerline axis of said threaded portion.

10. The multiaxial screw fixation system of claim **7**, wherein a centerpoint of said partial shape is aligned with a centerline axis of said screw head portion.

11. The multiaxial screw fixation system of claim **1**, wherein said screw head portion comprises at least one of a partial opening or partial shape that interfaces or connects with a tool, wherein said at least one of said partial opening or said partial shape is offset from an axis of said threaded portion.

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